

FRANKENSTEIN URBANISM

This book tells the story of visionary urban experiments, shedding light on the theories that preceded their development and on the monsters that followed and might be the end of our cities. The narrative is threefold and delves first into the *eco-city*, second the *smart city* and third the *autonomous city* intended as a place where existing smart technologies are evolving into artificial intelligences that are taking the management of the city out of the hands of humans.

The book empirically explores Masdar City in Abu Dhabi and Hong Kong to provide a critical analysis of *eco* and *smart* city experiments and their sustainability, and it draws on numerous real-life examples to illustrate the rise of urban artificial intelligences across different geographical spaces and scales. Theoretically, the book traverses philosophy, urban studies and planning theory to explain the passage from *eco* and *smart* cities to the *autonomous city*, and to reflect on the meaning and purpose of cities in a time when human and non-biological intelligences are irreversibly colliding in the built environment.

Iconoclastic and prophetic, *Frankenstein Urbanism* is both an examination of the evolution of urban experimentation through the lens of Mary Shelley's *Frankenstein*, and a warning about an urbanism whose product resembles Frankenstein's monster: a fragmented entity which escapes human control and human understanding. Academics, students and practitioners will find in this book the knowledge that is necessary to comprehend and engage with the many urban experiments that are now alive, ready to leave the laboratory and enter our cities.

Federico Cugurullo is Assistant Professor in Smart and Sustainable Urbanism at Trinity College Dublin, Ireland.

‘Federico Cugurullo draws inspiration and an analytical framing from Mary Shelley’s masterpiece to examine what he terms Frankenstein urbanism: experimental urban development designed to create sustainability that emerges with monstrous effects. His analysis is a powerful critique of the discursive and material creation of eco-cities, smart cities, and the coming autonomous city.’

Rob Kitchin, *Professor of Human Geography, National University of Ireland, Maynooth, Ireland*

‘In *Frankenstein Urbanism*, Cugurullo masterfully combines science fiction literature with an analysis of real-life cities, to show that fiction and reality are indistinguishable in our quest for autonomous urban futures. This is a theoretically bold and empirically rich book that illustrates how the current obsession about sentient cities is built upon the grand utopian gestures of smart and eco-city experiments turning into Frankenstein monsters. This book will be essential reading material for all those interested in the theory of urban futures as well as in the practical future of smart urbanism.’

Ayona Datta, *Professor in Human Geography, University College London, UK*

‘Does the new smart urbanity create a sort of Frankenstein monster, built with good intentions but turning against its masters? This book demonstrates that the only way out of the nightmare of Frankenstein urbanism is to begin loving our monsters. Leaving the city in the hands of technocrats only leads to a monstrous urbanism. That is why a public and politically engaging urbanity is urgently required. And this is precisely what the lessons of this book implore us to do.’

Erik Swyngedouw, *Professor of Geography, The University of Manchester, UK*

‘In this outstanding volume, Federico Cugurullo examines how humanity’s search for ideal cities– with their corresponding ideal societies– at times produces monsters. Frankenstein is an apt metaphor because, like the monster, the experimental forms of urbanism that Cugurullo discusses are terrifying but also very much alive. Well-documented case-studies in Abu Dhabi and Hong Kong explore the ambiguities and elitism of smart cities, perhaps the most salient manifestation of experimental urbanism. Cugurullo masterfully explains the futility and dangers of technological innovation without an overarching vision of urban futures. However, he argues that, rather than rejecting technology, we should approach it cautiously within a collective inquiry into the type of city that we want.’

Vanesa Castán Broto, *Professorial Fellow, Urban Institute, University of Sheffield, UK*

‘By mobilising a narrative of monstrosity, *Frankenstein Urbanism* builds a stunningly effective critique of the contemporary literatures, practices and consequences of the smart city. A compelling and vivid contemplation of some of the most pressing concerns about technology, its related ideologies, and the current condition of our cities.’

Alberto Vanolo, *Professor of Political and Economic Geography, Università di Torino, Italy*

‘*Frankenstein Urbanism* is a profound critique of smart and eco-cities and of the recent city of artificial intelligence. Federico Cugurullo remarkably discovers that the rationale for making these cities is analogically similar to the experiment that creates Frankenstein’s monster. Focusing on Masdar City and Hong Kong, the book provocatively rethinks what urbanism is in the technologically oriented initiatives transforming our cities.’

Fulong Wu, *Bartlett Chair of Planning, University College London, UK*

FRANKENSTEIN URBANISM

Eco, Smart and Autonomous Cities,
Artificial Intelligence and the End of
the City

Federico Cugurullo

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On an unusually rainy day, many years ago, my mum took me to see Branagh's *Frankenstein*. The cinema was old and dark, and it felt to me like we were in a different world, far away from my hometown Cagliari called *the city of sun* where the sky is rarely grey. Maybe I did enter another world, because after watching that movie, and later reading the book that had inspired it, my life was never the same. Thank you mum for buying that ticket and holding my hand.

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1

PROLOGUE

Of cities and monsters

Introduction

The narrative of this book follows Mary Shelley's novel *Frankenstein*. Stripped down of their technicalities and embellishments, the two books are essentially about the perennial tension between ideas, theories and visions on one side, and facts, practises and results on the other. They both focus on how what is believed to be unsustainable can, in theory, become sustainable, and on the monsters that the reckless pursuit of a development ideal can in practise generate. In Mary Shelley's book, the protagonist is a doctor named Victor Frankenstein. Victor strongly believes that the human being is not sustainable. Humans, he argues, are fragile creatures. They are vulnerable and prone to diseases. The human being was born to die. Whether through illness, injury or simply ageing, the human body will eventually decay and, for this reason, the human condition is one of unsustainability. These adamant beliefs which Victor keeps inside, are rooted in what is a tragic past. His mother died of scarlet fever when he was 17: an event which pushed him to embark on a quest for the creation of the ideal and perfect being, immune to death and to all the calamities in the world.

While Mary Shelley's novel explores the *human equation* or, in other words, the formula for the creation and enhancement of the human being, the present book deals with the *urban equation*. A plethora of cities are showing evidence of unsustainability. As first pointed out by Aristotle in ancient Greece, the city was originally created by humans to support human life. However, many cities seem to have now become dangerous places where people die prematurely and live a life of misery. Numerous academics, policy-makers, architects and planners have, like Victor Frankenstein, dark feelings about the past and the present, but see hope in the future. There is a growing awareness of the unsustainability of cities, followed by the realization that a formula for urban sustainability *has* to be found, and by the conviction (or perhaps the illusion) that such formula *can* be found. This mysterious formula is what the book calls the

urban equation. It is a method meant to identify the core elements of a city which combined in a given proportion are supposed to produce sustainable cities. How urban equations are being formulated nowadays, and the extent to which they are actually capable of achieving urban sustainability, will be recurring points of critical analysis throughout the book.

The words of Mary Shelley tell the story of a desperate scientist with the soul of a philosopher, who seeks to reshape the human fabric in search of perfection but, instead, ends up creating a monster. It is a story of intellectual inquiry, experiments and tragic revelations. This book tells the story of urban experiments. It is a story of visionary urban projects, of the theories that preceded their development and of the monsters that followed, and might radically alter cities to the point of ending them. The narrative is threefold and delves first into the *eco-city*, second the *smart city* and third the *autonomous city* intended as a place where existing smart technologies are evolving into artificial intelligences which are taking the management of the city out of the hands of humans. On these terms, *Frankenstein urbanism* means both a way of narrating the evolution of urban experimentation from *eco-* and *smart-city* experiments to *autonomous* cities, by using Shelley's *Frankenstein* as a framework, and an urbanism whose product resembles Frankenstein's monster: a fragmented entity which escapes human control and human understanding.

The urban equation

Victor Frankenstein's quest is ambitious not simply because its goal, creating the perfect human being, is enormously challenging from a scientific perspective. Victor's quest deals with nebulous concepts and questions which, despite many attempts, have never been fully answered. What the source of human life is and, above all, what the essence of being human is, are questions which have been puzzling scientists and philosophers alike for millennia (Scruton, 2017). It is therefore incredibly difficult, if not impossible, to develop the formula for the ideal human being, when the meaning of *human* is unclear in the first place. One might say that Victor has already failed even before embarking on his quest. The experiment attempted by the young scientist is flawed due to a lack of conceptual clarity. Victor cannot create what he does not fully understand.

The same problem can be seen in the context of urban sustainability. Creating a formula for sustainable urban spaces is not simply a scientific endeavour. Like the concept of being *human*, the notion of *urban* escapes a universal definition and its understanding is often ambiguous. The meanings of being urban, being a city and, more generally, urbanization, are not self-evident and not necessarily interchangeable. Rather than being solid like the stones of a city, the urban is a labyrinth made of mist, whose exploration can lead anywhere and nowhere. The term *urban* comes from the Latin word *urbanus* meaning *belonging to* or *of* the *urbe* which in turn means *city*. However, as repeatedly pointed out in the field of urban theory, what constitutes a city is hard to define, and this is where the academic debate tends to begin (Harding and Blokland, 2014; Iossifova et al., 2018; Jayne and Ward, 2016;

McNeill, 2016). Here the philosophy of Aristotle can be both a door to enter the labyrinthine debate over the urban equation, and a lantern to shed light on it. The remainder of this section draws upon Aristotelian philosophy to identify and discuss the core dimensions of urban settlements. Aristotle's thinking will be combined with insights from contemporary urban theory not to provide an absolute definition of the terms *city*, *urban* and *urbanization*, but to clarify how these notions are interpreted specifically in this book in relation to the study of eco-cities, smart cities and cities populated by artificial intelligences. In so doing, the chapter introduces a series of fundamental concepts which will be examined in more detail later in the book.

For Aristotle (2000), the city is the *ultimate* form of a *human community*. The emphasis on the words 'ultimate' and 'human community' is meant to highlight two key aspects that constitute a city. First, the city is not the only typology of human community. Being the ultimate one implies that a city is part of a process of development and, as such, it does not appear out of nothing: it comes from something. From an Aristotelian perspective, in order to understand where the city comes from, the focus is directed towards the evolution of human communities. For the Greek philosopher, a community (*koinonia*) has three forms. Each one representing a stage of human development. The first form is the family; the second is the village which unites different families; the third is the city which brings together different villages. It is important to note that underpinning the philosophy of Aristotle is the concept of *teleology*: the idea that everything has an inner potential or a final cause which can be reached through a process of development (Aristotle, 1996). What constitutes a city, therefore, does not manifest itself only in the city. The seeds of the urban are in the family living an isolated life. Urban seeds then grow into a small village. It is only through the evolution of families and villages that the urban flourishes and becomes evident in the city.

In his studies, Aristotle discusses the qualities that characterize human communities, including cities (Aristotle, 2000, 2004). According to his philosophy, the city is not only physical, and it goes beyond the built environment: it is also social and political. To explore this key point in-depth, semantic clarity needs to come before conceptual clarity. Aristotle uses three distinct terms in *The Politics* whose wording in ancient Greek can be found in copies of the classical text (see, for instance, Dreizehnter, 1970; Ross, 1957). These three words are *oikos* (οἶκος), *core* (κώμη) and *polis* (πόλις), and they represent the threefold evolution of human communities from families to villages and ultimately to cities. The *oikos* has three interconnected meanings. First, as a form of *koinonia* (community) it has a social meaning. In this sense, the term *oikos* signifies *family*. As mentioned above, for Aristotle, the family is the basic and earliest form of community or, in other words, social organization. The *oikos*, however, in the standard society of ancient Greece, does not comprise only two parents and their children, but also the slaves and the animals which serve the family. For this reason, translators like Sinclair and Lord prefer to use the word *household*, instead of *family* (see Aristotle, 1992, 2013). Second, the *oikos* has a political meaning, since the household requires a form of government

in order to function. For Aristotle, the different relationships within the household are regulated in a patriarchal way. The *oikos* is run by the husband and then, from a hierarchical point of view, comes the son, the wife, the slave and the animal. At the time of Aristotle, there were of course other typologies of domestic governance which prove the complexity and necessity of the political dimension of the *oikos*. In Sparta, for example, women had a stronger control over the household since men were often at war, away from home, or living in barracks (Blundell, 1995). Third, the household has a physical dimension and, as such, it has a physical location and a physical shape or, in architectural terms, a *built environment*. On these terms, *oikos* can be translated as *house*. Before the formation of villages and cities, the *oikos* extended beyond the house intended as an independent building, and included pieces of land used by the family for agriculture (Carr Rider, 2014; Morachiello, 2004). It was therefore an extended environment comprising the spaces necessary to obtain the resources needed by the family.

These three qualities (the social, the political and the physical) repeat themselves, like DNA strands, in the remaining categories of human community identified by Aristotle, *core* and *polis*, but they become more complex in terms of size and organization. The village, as the sum of different households comprises members of different families and, thus, requires a more sophisticated type of political organization, in order to function in a harmonious way. It also requires more space, a larger built environment, as well as more resources. The *polis* (whose matrix is the *oikos*) shares the same characteristics of the household and the village. The *polis* is first a social entity, since it unites numerous people originally from different villages or born in the city itself. Second, the *polis* is political because of the government that is required to coordinate all the activities that underpin its life and economy. Finally, it has a tangible physical quality, due to the many buildings, infrastructures and vast territory that its population needs to prosper (Aristotle, 2000). For these physical and socio-political dimensions, in the literature the term *polis* has been translated as both *city* and *state*. The specific lexicological choice varies from translator to translator. Laurenti, for example, suggests using *state* when Aristotle discusses the political organization of the *polis*, and *city* when the subject of the discussion is its physical structure (see Aristotle, 2005). For the purpose of this study, what matters is the understanding of the city as simultaneously and intrinsically social, political and physical. This view is in sync with twenty-first-century urban theory in which the nature of cities is approached in a multi-dimensional way, and the city is seen not merely as a physical artefact, but rather as a hyper complex entity made of social, political, economic and cultural processes (Heynen et al., 2005). This is a line of thought which will cut across the whole book, in order to shed light on the multiple dimensions of eco-city projects, smart-city initiatives and autonomous cities.

In Aristotelian terms, as discussed above, cities are part of a process of evolution. In this sense, urbanization can be understood as a socio-political and physical process whereby households become villages and villages turn into cities. This Aristotelian perspective should not be interpreted in a normative way given that there are always

exceptions to take into account, such as new cities built from scratch which are not extending from the family. However, this perspective is useful for seeing the city as part of a process of development which, in turn, leads to two important considerations. First, the scale of urban development tends to be addressed in contemporary debates in urban geography in a non-centric way, to avoid picturing the city as a rigid urban unit and as the sole manifestation of the urban. The work of Brenner (2019) and Schmid (2018), for instance, shifts the understanding of the urban outside the city and its centre, looking at the different scales through which the urban manifests itself. On these terms, as posited by Aristotle, the urban, although more prominent and evident in the city, can be found not only in the city. From this point of view, urbanity also lies, to a lesser degree, in the small settlements outside the boundaries of a city and, more generally, in all the infrastructure, supply chains and socio-political and economic activities that pivot around cities. The question of scale relates to the question of size: the amount of physical space that the built environment covers and where cities' activities extend to. For Aristotle, a household unit is relatively small when compared to a village, and a village is relatively small when compared to a city. Urban development is therefore seen as a process of growth through which urban settlements, and related infrastructures, supply chains and activities become bigger, thus covering and influencing more geographical spaces. In the fourth century BC, Aristotle could not predict that some cities were going to become megacities. He could also not foresee that urban spaces would exponentially grow and multiply, creating a condition that a strand of urban studies defines as *planetary urbanization* in which the boundaries of cities are becoming blurred (Brenner, 2014; Lefebvre, 2014/1987; Peake et al., 2018; Williams et al., 2020; Wilson and Jonas, 2018). Urban spaces, infrastructures and services are spreading globally, thereby transcending the city as a self-contained unit. The world is opening up as the stage where the urban spectacle takes place.

Second, seeing the urban as a process, through the lens of Aristotle's philosophy, points towards what sustains the process. For Aristotle (2000), urban growth necessitates a number of resources. The development of villages, their growth and integration into a city, and the genesis and development of the city itself, require food, metals, stones, animals and, of course, humans. In the first part of *The Politics*, the Greek philosopher lists some of the key arts that are needed in order to cultivate the seeds of the urban. Arts which range from agriculture to metallurgy, and from fishing to trade. It is again a question of scale. He notes, for instance, that 'in the first form of *koinonia*, which is the family, it is obvious that there is no purpose to be served by the art of exchange. Such purpose emerges only when the community is larger' (Aristotle, 2000: 25). Ultimately, Aristotle sees a human community, across its three main incarnations, as a living entity which consumes resources to grow, and the city, being the largest typology of human community, as the entity whose life requires resources the most. This perspective reflects current studies on urban metabolism, which put emphasis on the many flows of materials and energy underpinning the life-cycle of cities (Beloin-Saint-Pierre et al., 2017; Conke and Ferreira, 2015; Pincetl et al., 2012).

It is also important to note that urban development is not geographically homogenous, meaning that the three forms of community identified by Aristotle can be present, at the same time in different geographical spaces. In other words, the village does not always and everywhere replace the household and, similarly, the city does not absorb all villages. Although the city is his ideal form of community, Aristotle is the first person to recognize that cities can be found next to villages around which single households coexist. What Aristotle insists on is the urban nature of the human being which, he argues, should not live outside cities. Out of the city are only immortal gods which are born perfect and, as such, can live independently, while due to their limitations, out-of-the-urban humans would be vulnerable and 'in the position of a solitary advanced piece in a game of draughts' (Aristotle, 2000: 10). For the Greek philosopher, humans are essentially urban animals which need urban settlements to survive and cities, in particular, to develop and fulfil their potential. From a theoretical perspective this is an important point, inasmuch as it captures the idea that the condition of humanity depends on the condition of urbanity and that, for humankind to flourish, cities are necessary. Regardless of what philosophical stance is taken into account, from a practical point of view it is a well-known fact that most of the global population now lives in cities, and human life has largely become urban life. These reasons alone would suffice to make the urban equation an unavoidable research topic. If human nature, and therefore also the urban nature of the global population's distribution, cannot be changed, it is then imperative to understand how cities can become more sustainable. In order to do so, it is crucial to first unpack the meaning of urban sustainability.

Urban sustainability

As this book will show, a single formula for urban sustainability does not exist. Despite the influence of global discourses, the very idea of sustainability tends to vary according to specific geographical contexts, under the influence of local cultures, politics, economies and physical environments (Whitehead, 2003, 2007). Likewise, the notion of what makes an urban space sustainable is geographically sensitive (Angelo and Wachsmuth, 2020; Hansen and Coenen, 2015; Truffer et al., 2015). Ultimately, as Lefebvre (2009: 31) remarks, every society 'produces a space, its own space' typical of its socio-cultural attributes, and it would be therefore problematic to theorize a universal sustainable urbanism. Yet, it is possible to recognize some key aspects of urban sustainability, in line with the key aspects of cities, which are common across different geographical spaces. To this end, the philosophy of Aristotle can be used again as an entry point to navigate the complex debate over the meaning and practise of sustainable urbanism. The aim here is not to provide an in-depth analysis of the concept of urban sustainability, but rather to shed light on its complexity and identify its core dimensions: an exercise that will be related later in the book to specific case studies and their formulas for a sustainable urban development.

First, there is the issue of the scale of urban development. For Aristotle, as noted before, the city is the ideal form of human community and in *The Politics* he stresses the importance of carefully defining its size and boundaries. From a political point of view, for him, a large city can be dysfunctional, inasmuch as a good form of government must be based on the citizens' knowledge of each other. Within the ideal political system of Aristotle, citizens can vote for the election of their governors, thereby determining who will rule the city and make important decisions which will eventually affect the life of every individual. However, 'both in order to give decisions in matters of disputed rights, and to distribute the offices of government according to the merit of candidates, the citizens of a city must know one another's characters' (Aristotle, 2000: 262). In cities where the population is too large, Aristotle argues, it becomes almost impossible for their inhabitants to even see each other, let alone know each other intimately. In these cases, government and elections 'operate by guesswork' (Aristotle, 2000: 263). In terms of geography, urban planning, urban design and economics, the Greek philosopher points out that the larger a city is, the harder it is to find space for it, to construct enough buildings and infrastructures, and to obtain and circulate all the resources that its population requires, particularly 'commodities which the city does not itself produce' (Aristotle, 2000: 265).

From an urban sustainability perspective, the problem of scale is today a pressing one (Bettencourt and West, 2010; West, 2017). The reasons are not dissimilar from those highlighted by Aristotle. The governance of large cities, particularly when it comes to the development of urban policies targeting sustainability, is weighted down by the myriad of actors, offices and procedures that frequently populate overgrown political entities (Bulkeley et al., 2014a; Rode et al., 2020; Vitz, 2018). The materiality of large-scale cities is per se problematic, even in politically efficient contexts. On the one hand, urbanization is commonly understood as *production of space* (see Lefebvre, 2009). However, on the other hand, the formation of space, whether in the shape of housing, industry or transport, for instance, requires the *destruction of space*. The process of urban development does not take place on a blank canvas, but rather on complex and, in many cases, fragile ecosystems, such as rivers, forests and lakes. Urbanization creates space, while simultaneously destroying the space that was previously there. In ecological terms, a greater scale of the urban often implies a greater environmental degradation (Chen et al., 2020). Emblematic is the case of China where the physical growth of cities has caused, since the 1990s, major loss of natural habitat. In 2011, the urban population of China (which was barely 26 per cent in 1990) reached 51.3 per cent, through an incessant production of built environments which wiped out approximately a quarter of all the country's forest and water coverage (He et al., 2014; Li et al., 2015; Wang et al., 2015; Zhang et al., 2020). Being ecologically sensitive is thus key to the formulation of a sustainable urbanism, and this is a theme which will become prominent later in the book when the narrative will centre on *eco-cities* supposed to combine the science of ecology with the art of city-making.

Urban history shows that this is not a new phenomenon. As Mumford (1961) notes, the environmental impact of urbanization became prominent and evident in

the sixteenth century, particularly in Europe, when the production of urban spaces began to mean a drastic reshaping of the physical geography of a region. Mumford (*ibid.*) points out that while the medieval city had grown on and around surface features, the baroque city was less sensitive to local topography, and tended to impose its regular layout on the environment. Land levelling is a trademark of sixteenth-century urbanism: a practise which was implemented to remove irregular areas, and build straight streets essential for the development of early forms of trade-based capitalist economies (Conforti, 2005). What is unprecedented and worrying nowadays is the scale of the phenomenon. Although with notable geographical differences, the planet's urban mass is growing exponentially (Elmqvist et al., 2018; Melchiorri et al., 2018). While the population of European urban settlements is shrinking, in Asia, Africa and Latin America existing cities are expanding and new ones are being built, accounting for over 90 per cent of global urbanization (Datta and Shaban, 2016; Herbert and Murray, 2015; Wolff and Wiechmann, 2018; Zhang, 2016). In Africa, for example, the urban population is expected to triple by 2050, and the environmental costs of the extension of the built environment are already being paid with biodiversity loss and the depletion of regional ecosystems (Baldyga et al., 2008; Côté-Roy and Moser, 2019; Güneralp et al., 2017; Van Noorloos and Kloosterboer, 2018; Were et al., 2013).

Second, there is the issue of the metabolism that maintains the growth of cities and the genesis of new urban settlements. Like a living organism, a city needs a plethora of substances which are broken down and assimilated to yield energy, build infrastructure and eliminate waste. It has been estimated that cities consume approximately 75 per cent of natural resources, including fossil fuels, metal ores, non-metallic minerals and biomass (Pincetl, 2017; UNEP, 2014, 2016). Urban spaces absorb these flows of energy and materials which do not necessarily originate from them since, as noted in the past by Aristotle, a city needs to import what it does not produce enough of. What was, in Aristotle's time, a *need* has now become a *dependence*. While the global urban population keeps growing, the United Nations Environmental Programme stresses that local resource scarcity makes cities reliant on imports and on the development of 'complex infrastructure systems to transport essentials such as water, food and energy' (UNEP, 2017: 4). The criticality, and unsustainability, lies in the scarce supply and finite nature of much of the resources needed by the contemporary city.

Furthermore, the metabolism of cities not only consumes, but also produces. Across different scales, cities are responsible for approximately 70 per cent of global carbon emissions, and impact on the atmosphere and weather systems, thereby contributing to climate change (Bai et al., 2018; IPCC, 2015; Moran et al., 2018; Sudmant et al., 2018). Overall, considering the weight that they impose on global environmental changes, cities can be seen as contributors, if not the main actors of the so-called *Anthropocene*: a new and contested geological era in which humans are the dominant force behind the shaping of climate and the environment (see Lewis and Maslin, 2015; Steffen et al., 2007). As Pincetl (2017) notes, the majority of humans now live in cities and the Anthropocene, as an age shaped by humans, can

consequently be understood as an age of cities or, in the words of West (2017), as the *Urbanocene*. From a more philosophical perspective, if the nature of the human being, as posited by Aristotle (2000), is intrinsically and inescapably urban, being *anthropos* implies being urban and, on this basis, living in the age of the *anthropos* implies living in an urban age.

Somehow paradoxically, the age of the *anthropos*, also the age of the urban, is an era in which the *anthropos* is not safe. In cities like Beijing, due to urban pollution, it is estimated that the life expectancy of citizens is being reduced by an average of 15 years, while in urban India every year thousands of people die prematurely because of poor air quality (Ghude et al., 2016; Guo et al., 2013; Lelieveld et al., 2015). Many cities have become deadly. Although caution is needed to avoid generalization, evidence suggests that the city is not supporting what Aristotle (2000, 2004) calls *eudaimonia*: human flourishing intended as the process through which humans realize their inner potential, thus reaching a state of satisfaction and happiness. Studies on the geography of happiness, for example, indicate that city dwellers tend to manifest a chronic lack of happiness, and that vast and hyper dense cities, due to a combination of long commutes, pollution, harmful noise, excessive artificial light and lack of therapeutic spaces like parks and bodies of water, impact negatively on wellbeing (Okulicz-Kozaryn, 2015; Okulicz-Kozaryn and Mazelis, 2018). Furthermore, in the majority of cases, when a city promotes the flourishing of its inhabitants and their happiness, the process is uneven. As shown particularly in the field of urban political ecology, the same social, political and physical dimensions of the urban that were highlighted by Aristotle, are producing and reproducing injustice (Harvey, 2009; Heynen et al., 2005; Kaika, 2005). Urbanization is creating spaces where large segments of the population are politically underrepresented, have little or no access to basic resources (such as energy and food), and are unevenly exposed to the burdens of the Anthropocene (Bouzarovski and Petrova, 2015; Hodson and Marvin, 2010; Sonnino, 2016). These grave problems indicate that the way cities are currently being planned, governed and experienced is largely unsustainable, and it is out of this realization that a global impetus for alternative urban models is emerging.

Experimental urbanism and the ideal city

In this context of global urban concerns and challenges, urban experimentation has become a popular way to address the unsustainability of cities, through the development of supposedly alternative models of urbanization (Bulkeley et al., 2014b; Bulkeley and Castán Broto, 2013; Bulkeley et al., 2019; Caprotti and Cowley, 2017; Evans et al., 2016; Karvonen and van Heur, 2014; Raven et al., 2019). The argument advanced by those in favour of urban experiments is that the current canons of city-making are flawed and, as such, they must be replaced. In itself, this claim is not new and has been heard many times throughout the ages. The city has always been a site of experimentation (Evans, 2011). Urban history is full of

characters like Victor Frankenstein which have tried, across different spaces and times, to develop novel urban equations, claiming to possess the formula for the ideal city.

The Renaissance, for instance, with its cultural and philosophical emphasis on the human being as a creature capable of controlling destiny, by shaping the surrounding social and physical environment, presents several examples of projects for ideal cities (Kruft, 1989). These were not simply attempts to create perfect built environments, but rather experiments using the built environment to create an ideal society (Rosenau, 1983). The aim was not to create a geometrically perfect and aesthetically beautiful urban space. Architecture, urban design and planning were instruments serving political philosophy. In the context of the ideal-city phenomenon, the word *ideal* has a double meaning with only a tenuous connection to aesthetics. *Ideal* as an adjective referring to the best and most desirable city and, most importantly, *ideal* as a set of ideas of society and politics, upon which the genesis of the city is based. On these terms, Sforzinda, a project for a new city developed by Italian architect and philosopher Filarete as part of his *Trattato di architettura* (*Treatise on Architecture*), in the second half of the fifteenth century, is emblematic (Figure 1.1). Sforzinda manifests the effort to combine an ideal urban form with an ideal social form, in order to create what in the mind of its developer was the most desirable city.

The master plan for Sforzinda is characterized by a marked regular layout. The city has a radio-centric structure with a radial scheme for streets and canals, and an orthogonal scheme for squares and public buildings (Calabi, 2001). The centre of the city is designed as a vast public space around which Filarete positioned politically prominent buildings, such as the palace of the prince and the mint. However, Filarete's *Trattato* does not deal only with the geometry of the city. It also specifies the type of society that Sforzinda wants to cultivate and represent. First, the author aimed to create a homogenous society, in the attempt to avoid social fractures. Every area of the city is, to this end, connected through 16 radii and a wide circular street linking 16 minor squares to each other. This urban design was not meant to be purely functional from a mobility perspective, but to connect all citizens by opening up the city and promoting social encounters. In terms of housing, the master plan was tailored around concerns about poverty and affordability, which the author addressed by designing houses and buildings of different sizes and costs. There is an explicit aspiration for inclusive design, as Filarete sought to include mountain dwellers (then largely excluded from cities) within the walls of his ideal city. Second, the new ideal city was designed to refine the conscience of its citizens and reach moral and civic perfection. In this sense, emblematic in Filarete's plan for Sforzinda is the establishment of the House of Vice and Virtue: a ten-story building with a brothel on the ground floor, lecture rooms in the middle and an academy at the top, supposed to guide the ascent of man from vice to virtue.

After Sforzinda, the quest for the ideal city has been attempted by many architects, philosophers, urban planners and politicians which, like Filarete, rejected the

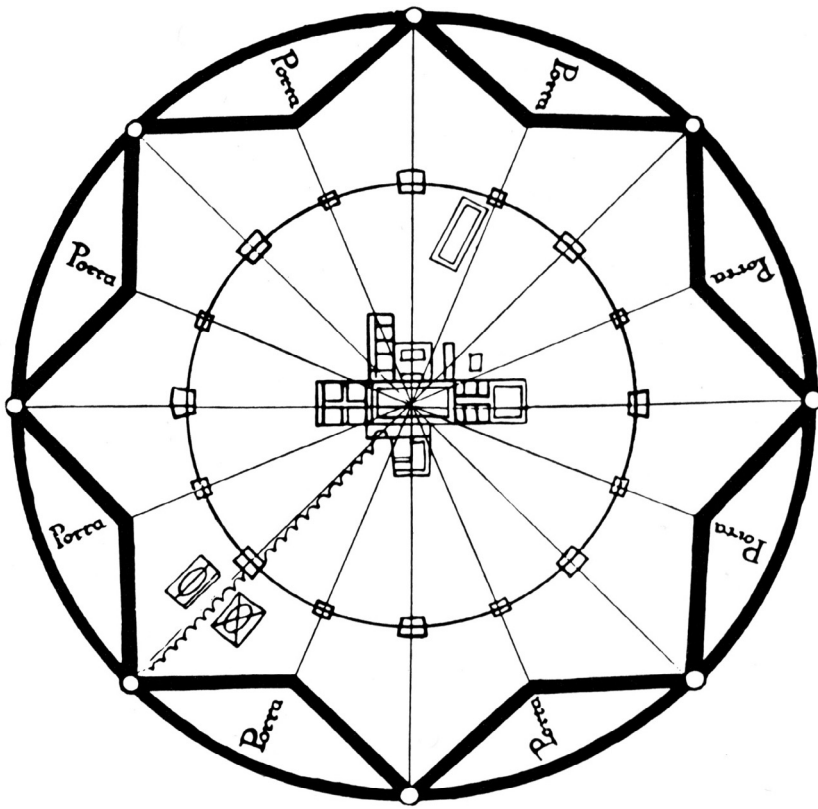


FIGURE 1.1 Master plan for Sforzinda (circa 1464).

Source: Wikimedia Commons

then mainstream models of city-making and proposed alternative urban equations. In the Enlightenment, a notable example is Chaux, a master-planned new town envisioned by French architect Claude-Nicolas Ledoux (1736–1806), to incarnate the avant-garde political ideas of Montesquieu and Rousseau (Kruft, 1989). Later emblematic attempts were made by Ebenezer Howard (1850–1928), Frank Lloyd Wright (1867–1959) and Le Corbusier (1887–1965), who brought new ideals and designs, giving different shapes to the ideal city (Fishman, 1982; Pinder, 2013). Howard's Garden City, for instance, sought to eliminate the barriers between the city and the countryside and blend their lifestyles within compact settlements, while in Wright's Broadacre the 'central belief was individualism' and houses were thus designed as independent and scattered units reachable by car and helicopter (Fishman, 1982: 94; Howard, 2007). The thread of urban experiments is long and cuts across many eras. Century after century, ideas have kept changing and so too the techniques, strategies and technologies employed to turn ideals into stone, and visions into actual cities. Yet, through the long and

heterogeneous history of experimental urbanism, it is possible to find some recurring elements.

First, experimental urbanism seeks to develop alternative spatial forms, in order to develop alternative socio-political forms. The example of Filarete's Sforzinda shows that the city is understood not simply as a physical construct, but rather in an Aristotelian way as a social and political entity. On these terms, urban experimentation tackles the design and infrastructure of the city, with the aim of changing its society. The experimental city is not only composed of the built environment. The people who reside in the built environment and the governance that regulates their urban life, are equally important dimensions of urban experimentation. Second, experimental urbanism is openly part of a counter-current movement. Experimental urban projects start as a niche, with the ambition of setting a new paradigm meant to redefine the idea and practise of the good city. Their premise is that the state of affairs of cities is problematic and undesirable, and that alternative and better formulas of urban development have to be found. Here the notion of the experimental city overlaps with that of the good city, since urban experimentation is ultimately supposed to eliminate what is undesirable in cities and replace it with spaces and societies that, for the developers, are *good*, *right* and *desirable*. Third, there is the implicit assumption that better formulas of city-making *can* be found and implemented. In this regard, experimental urbanism manifests evident traits of *modernity* intended as the capacity of dreaming of alternative realities, coupled with the belief that dreams can be realized, particularly by means of science and technology (Berman, 2000; Boyer, 1997).

Fourth, experimental urbanism is prone to failure, since it is in its nature to deal with theories and practises of city-making which have not been tested before and, as such, are uncertain and potentially risky. However, an experimental urban project that fails can nonetheless be influential, eventually having a material impact on the built environment and an immaterial impact on the way urban planners, architects and policy-makers think about the city. The theory of the Garden City, for example, was never implemented exactly as it was originally envisioned by Ebenezer Howard, but it inspired and influenced the construction of numerous cities from around the world and its legacy is still standing (Hall, 2002). Moreover, even when an urban experiment collapses before reaching the implementation stage, future urban developers can learn from the failure of their predecessors, and integrate similar if not the same old ideas into new projects (Chang, 2017; Lovell, 2019; Temenos and Lauermaann, 2020).

Fifth, urban experiments can be highly subjective visions. Sforzinda, Chaux, the Garden City and Broadacre, for instance, were proposed by singular individuals as the product of individual imaginations. Therefore, while experimental urbanism has the potential to advance alternative urban ideals, the outcome can be a new but narrow vision of the good city, since what is *good* and *bad*, *right* and *wrong*, *ideal* and *undesirable* is not defined by a collective intellectual inquiry or public political debate. This aspect is discernible not only from an imaginary and ethical perspective, in terms of what and whose ideas are taken into account and the value that is

placed on them. The geographical and temporal perspectives might be narrow too in their looking exclusively at a specific space and time, thereby ignoring the applicability of the same ideal in different contexts, or simply assuming that a given ideal is universally and always valid and applicable. Urban experiments recurrently impose a rigid vision of the future, an *urban future* which clashes against the fluid and indefinite *yet to come*. The individualistic character of many experimental urban projects has also been, historically, one of the main reasons why large-scale urban experiments have rarely succeeded. In this sense, although distant in time and space, Sforzinda and Broadacre are related by the fact that their inventors failed to create or join a network capable of financing the projects. As a result, none of them was built and both fell into the realm of utopia (Fishman, 1982; Kruft, 1989).

Sixth, practitioners of experimental urbanism tend to test and implement their theories under controlled conditions (Evans and Karvonen, 2011). This typically means that the experiment starts with a city, or part of it, whose development is monitored and regulated. The objective is usually to scale up the experiment at a later stage, if it is successful. This is an aspect of experimental urbanism which indicates the diverse scales of urban experimentation. Small-scale urban experiments can target a district or even just a single building, and then potentially extend their influence to the whole city. A large-scale urban experiment might involve building a new city from scratch, which can subsequently serve as a model for the construction of similar cities across the country. Along this spectrum ranging from modest interventions to grandiose mega-projects, while the scale is different, the ethos of experimentation and the will to change the built environment in order to trigger broader social and political changes remain. Seventh, the implementation of experimental urban projects is frequently disciplined by a master plan which is supposed to provide developers with a scientific methodology (Cugurullo, 2018). Master plans set and arrange the steps necessary to complete urban experiments, determining what has to be built, how, where and when. This is often the ground upon which advocates of experimental urbanism, claim that this typology of city-making differs from a standard and more chaotic process of urban development.

Finally, and arguably most importantly, all the points above can be *false*. There can be strong differences between what the developers and promoters of a supposedly experimental urban project claim and what is actually happening on the ground. In classical and modern philosophy, this is commonly understood as *correspondence theory*, the idea that a statement does not necessarily correspond to a fact (see Kirkham, 1992). History abounds with allegedly experimental, innovative and ideal cities whose reality was far from what developers and stakeholders had claimed. Valletta (Malta), for instance, whose construction (1566–1573) was co-financed by Pope Pius IV and various members of the European aristocracy, in theory to incarnate the ideal of Christianity into a city, was in reality a fortress meant to keep Ottoman pirates at bay, and preserve trade in the Mediterranean Sea (Kruft, 1989). There was thus a stark discrepancy between the discourses through which Valletta was being promoted (a city supposed to protect the ideas and values

of Christianity) and the actual Valletta (a city protecting long-standing power relations and politico-economies). Here the adjective *false* describes an urban project that is promoted as experimental, counter-current and as a medium to realize certain ideals, while the facts show otherwise. In the twenty-first century, critical scholars working in the field of experimental urbanism have been investigating the extent to which contemporary experimental urban projects are actually driving real change and achieving urban sustainability, questioning the assumptions of what are promoted as, but not necessarily are, *experimental cities* (Castán Broto and Bulkeley, 2013; Cugurullo, 2016; Kaika, 2017; Karvonen et al., 2014; McGuirk et al., 2014; Savini and Bertolini, 2019).

This book focuses on the most popular and influential typologies of experimental urbanism of the twenty-first century: the *eco-city*, the *smart city* and the emerging *autonomous city* run not by *human* but by *artificial* intelligences. It examines the theories behind their genesis and assesses their implementation, evaluating the extent to which these supposedly experimental and sustainable urban projects are achieving sustainability. The story of eco, smart and autonomous cities is not linear, and here lies a key difference between this text and its literary guiding spirit, *Frankenstein*. While profound, intellectually sophisticated and enriched by the perspectives of different characters, Mary Shelley's book follows a fairly linear narrative. *Frankenstein* has a protagonist, several secondary characters and an antagonist. The protagonist embarks on a quest which starts from a clear and familiar context, to then push the story into the unknown. This book has a plethora of protagonists. Many of them are hidden, and do not even have a human face. The context in which they operate is, from the very beginning, ambiguous and tends to become amorphous step by the step. The following chapters are an attempt to give a narrative to the dubious development of eco-cities, the hazy creation of smart cities and their complex evolution into cities controlled by enigmatic artificial intelligences.

Methodology

Giving a narrative is about ordering seemingly disparate and obscure events into a coherent story. The narrative of this book unfolds through a case-study approach. From an empirical point of view, most of the focus is on the analysis of two cities: Masdar City in Abu Dhabi as an example of a new eco-city project, and Hong Kong as an instance of a large-scale smart-city initiative. The rationale behind the choice of Masdar City and Hong Kong is twofold. This study does not aim to offer a comparative analysis, but rather a detailed and empirically rich examination of contemporary urban experiments, first in the two mainstream typologies of experimental urbanism (eco-cities and smart cities) and second in the two main types of built environment (new cities and existing settlements). Fieldwork was conducted, at different stages, in Abu Dhabi and Hong Kong across 2010 and 2016, for a total of 18 months. Regarding the autonomous city, the phenomenon of built environments operated and governed by *urban artificial intelligences* is an emerging one and, to date, there is scarce empirical ground for in-depth case-study

research (Cugurullo, 2020). Autonomous cities are crossing the frontiers of urban experimentation, entering multiform territories which are largely uncharted. Therefore, the book explores the autonomous city by drawing upon diverse real-life examples, with the aim of unveiling the heterogeneous and complex spectrum of the use of artificial intelligence (AI) in cities, rather than analyzing one individual aspect in detail.

Much of the information disclosed during the research on Masdar City and Hong Kong's smart-city agenda is controversial in nature and not publicly available. A total of 35 semi-structured and 23 unstructured interviews were conducted with members of the public sector, such as policy-makers, developers and spatial planners from local planning councils, as well as representatives from architecture firms, investment companies and clean-tech multinationals. In addition, key documents, including master plans, development agendas and environmental reports, were examined to triangulate the information that emerged in the interviews. The data provides evidence of the many problems which undermine the sustainability of the two projects, clashing with the claims of developers and stakeholders. In order to protect the anonymity of the participants, across the empirical chapters all the names of the interviewees have been replaced by their role and position. Following the same ethical considerations, the book does not refer directly to the documents that are not public, as this would expose the identity of those who shared them.

From a theoretical point of view, the book employs its empirical basis to propose general theories and critiques of experimental urbanism. As Flyvbjerg (2006) remarks, in-depth case studies can provide precious insights into broader phenomena, thus turning specific information into general knowledge. Along this line of thought, the specific cases of Masdar City and Hong Kong serve the purpose of capturing general trends in urban experiments such as, for example, the emergence of AI in the governance of cities. However, given the limitations that are intrinsic to case-study research, the objective of the book is not to provide rigid one-size-fits-all conceptual frameworks. On these terms, the following arguments are animated by a philosophy of research akin to what Peck (2017a, 2017b) defines as *conjunctural urbanism*. The book approaches contemporary experimental urban projects, first as part of a broader and much older trend in urban development since, across history, cities have been recurrently used as vehicles to experiment with alternative forms of social organization. Second, urban experimentation is here understood as a situated and diverse phenomenon connected to the specificity of the single case studies. Therefore, by approaching the subject of inquiry as the interconnection or conjuncture of these two dimensions, the book seeks to offer a 'midlevel formulation' whose explanatory power and generalizability remain open and revisable (Peck, 2017a: 19–20).

Structure of the book

The book is divided into three parts which mirror the unfolding of the events narrated in Mary Shelley's novel. In the first part, *The literature*, the focus is on the

key ideas and theories of ecological urbanism and smart urbanism. Before delving into his experiment, Victor spends several years studying, reading books and absorbing the literature. He knows that what he is about to empirically attempt has already been the subject of many studies. Conscious that there is a lot to learn from the scholars that came before him, Victor reviews and tries to make sense of a very heterogeneous literature. Given the complexity of his field of research, the young scientist engages with a broad spectrum of disciplines ranging from chemistry to physiology. In so doing, he learns about the principle of life, how a human being becomes such, and how the human body can, in theory, be perfected. Following this narrative, in Chapters 2 and 3, the book reviews and discusses the literature on eco-cities and smart cities, as a way to understand the conceptual foundations of eco-city and smart-city projects. Like in the case of Victor Frankenstein, this is not just a literature review. There is not a single source or discipline behind the notions of the eco-city and the smart city. Instead, there are fragmented ideas, visions and images coming from diverse and, at times, contrasting fields of knowledge. The first part of the book, therefore, seeks to connect the dots or, put differently, the threads that, when woven together, form the principles of eco-city-making (Chapter 2) and smart-city-making (Chapter 3). This is a journey cutting across different branches of environmental philosophy, planning theory, urban design, political science, political philosophy, geography and more. By the end of Part I, the book aims to have clarified the often obscure and misused terms *eco-city* and *smart city*, to then move to their empirical incarnations.

In the second part of *Frankenstein*, Mary Shelley describes the empirical work of Victor Frankenstein. After having spent a considerable time surrounded by books, the Doctor surrounds himself with a complex array of tools, machines and materials. He is ready (or so he believes) to finally conduct his experiment and put the theory into practise. Victor locks himself up in a laboratory and the experiment begins. In the second part of this book, *The experiment*, the focus is on the practise of ecological urbanism and smart urbanism. Chapter 4 explores an actually existing project for a new eco-city, while Chapter 5 investigates the implementation of a smart-city agenda. These two chapters form the empirical core of the book. Data collected in the field is here used to examine where, how, why, for whom and by whom experimental projects for eco and smart cities are developed. The book seeks to shed light not simply on what is happening on the ground, but also on the discrepancy between the ideas of eco-city and smart city and their empirical incarnations. The empirics cover different scales and manifestations of the urban as it is shaped by eco and smart-city initiatives. The lens of inquiry moves from single buildings to districts, and from the entire city to the surrounding region, thereby revealing the many facets of being *eco* and *smart* in an urban context.

The third part of Mary Shelley's novel deals with the consequences of the experiment conducted by Victor. Eventually, the Doctor has to face what he has created and confronts the repercussions of his actions. The result of the experiment is a creature which is alive and independent. It has its own agency. It acts. It evolves, turning into something which Victor had not expected before he started

experimenting. Ultimately, for him, the outcome of the experiment comes as a tragic revelation or, in other words, an apocalypse. In the final part of this book, *The apocalypse*, the narrative unveils the results of the urban experiments developed through eco-city and smart-city initiatives. Chapter 6 problematizes the sustainability challenges produced by alleged eco-cities and smart cities, and emphasizes their fragmented and dysfunctional character, by using Frankenstein's monster as a metaphor. Chapter 7 investigates the evolution of experimental urban projects in light of recent advancements in AI which are introducing autonomous technologies in the management of cities. Here the book depicts an emerging autonomous city: a space, born out of years of eco and smart-city experiments, where diverse artificial intelligences, from service robots to digital platforms, perform urban activities that have traditionally been human activities. Chapter 8 consists of an epilogue looking at the possible urban futures that lie ahead, too far for being now real, but not too far for being realizable. The scenario that is presented shows cities radically altered by AI to the point of losing those key qualities and characteristics that make them cities in the first place. The end of the book is about the end of the city, intended not as a global calamity causing the destruction of urban spaces, but rather as the termination of the city as a place predominately governed, planned and experienced by human intelligences.

While this book deals with the future, it does not try to predict it and its analysis of past and present urban experiments is meant to understand and evaluate the directions that urban development is currently taking. Directions that are not carved in stone and that should and can be changed. The tale of Frankenstein is a warning. Frankenstein's experiment gets out of control and its results are deadly. Blinded by hubris, Victor irresponsibly creates and then abandons a powerful being whose integration into human society proves to be disastrous. Similarly, the tale that follows shows how in the passage from eco and smart cities to the autonomous city, a reckless technological development is producing urban spaces which humans barely control, scarcely understand and might not be compatible with. This tale is a warning too. Cities are heading toward a dangerous future and must be careful. Sooner or later, humanity will have to respond to the outcomes of experimental urbanism. Victor's response to the monstrosity of technological experimentation is *hatred*. He gives up science and finds in a gun the answer to his problems, in the attempt to kill the monster that he has created. This book's response is *love*. Love as making an effort to understand the numerous human and non-human intelligences that populate cities, by using the tools of the social sciences and humanities. Artificial intelligences, in particular, since their arcane explainability is a barrier preventing many people from understanding and trusting them (Barredo Arrieta et al., 2020; Stoyanovich et al., 2020). Love as politics here is intended as an invitation to actively engage with urban experiments as a community of informed citizens, sharing ideas, debating, voting, protesting when necessary and striving to include missing ideals of justice and ecology in the engine of experimental urbanism. Victor fails his experiment because he fails to know, to empathize and to engage. The following pages provide the knowledge that Victor was lacking in the hope of

stimulating empathy for and engagement with the urban experiments that are now leaving the laboratory and entering the everyday.

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